Tennessee Largemouth Bass Management Plan for Lakes and Reservoirs

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Forward

The purpose of a fish species management plan is to outline criteria that can be incorporated into management plans for specific water bodies. The Tennessee Wildlife Resources Agency (TWRA) will develop management plans for each species comprising a major fishery in state waters in an effort to establish management guidelines based on the biological capacity of recipient waters. TWRA field biologists will be responsible for writing management plans for the streams, reservoirs, or lakes that they oversee. Species management plans will allow them a variety of management options based on numbers obtained from analysis of historical data on each water body.

Species management plans reflect the need for diverse fisheries in Tennessee waters. Some reservoirs may have the biological capacity to support six sport fisheries while others may be limited to one or two species. Some impoundments may be able to support a trophy fishery, and biologists with substantial public support will want to recommend management strategies to promote that fishery.

Much of the emphasis of TWRA's Largemouth Bass Management Plan is in defining the rationale behind specific management recommendations and the goals of programs aimed at providing a diversity of fishing opportunities for the citizens of Tennessee. More complicated or controversial programs such as trophy bass management are highly detailed in the plan while simple minimum size limits are discussed in less detail. This does not imply that one management option is more important than the other, but rather reflects the complexity of the issue of trophy bass management and defines the ranges of biological parameters that make it justifiable.

This document will be used by the TWRA biologists to justify their annual reservoir and agency lake management recommendations to the Tennessee Wildlife Resources Commission (TWRC). The plan will provide a foundation for annual recommendations and define realistic management goals given the variability in productivity of waters across Tennessee.

Acknowledgments

The TWRA largemouth bass management plan was adapted from the format of Arkansas Game and Fish Commission's (AFGC) Arkansas Largemouth Bass Management Plan. Conversations with Mike Armstrong of AFGC helped shape the direction of our plan based on their experiences with the first edition of their bass management plan. Problems and solutions unique to Tennessee bass fisheries have been included in the TWRA plan along with an extensive base of supporting literature. Our appreciation goes out to TWRA Environmental Services Division's Richard Kirk and Binney Stumpf of Tennessee Tech University's Water Center for graphical and cover support.

Internal review for the plan was provided by Bobby Wilson, Assistant Chief of Fisheries; Region I agency lakes biologist Dave Rizzuto; and TWRA regional reservoir biologists Tim Broadbent, Doug Pelren, John Riddle, Anders Myhr, and Doug Peterson. Thanks are also extended to TWRA regional administrators Harold Hurst (retired) and Danny Scott for their comments on the first draft. Comment on early drafts of the document was also received from several members of the Tennessee Wildlife Resources Commission (TWRC).

External review was provided by Mike Armstrong (AFGC), Jim McHugh of Alabama Wildlife and Fisheries Division, Mike Duval of Virginia Game and Inland Fisheries, Vic DiCenzo of Texas Parks and Wildlife, Scott Van Horn of North Carolina Fisheries and Boating Commission, Phil Bettoli of Tennessee Tech University, and Bruce Shupp of B.A.S.S., Inc.. Public comment was obtained from members of Tennesssee's bass fishing community which was solicited through public news release.

Introduction

Largemouth bass (*Micropterus salmoides*) have long been considered one of the premier sportfish in Tennessee reservoirs. Directed fishing effort for this species accounts for approximately 40-50% of total targeted effort by reservoir anglers (Jakus et al. 1996; O'Bara 1998). Due to the immense popularity of largemouth bass angling, effective management of the species has been a major goal of the Tennessee Wildlife Resources Agency (TWRA) and its predecessor the Tennessee Game and Fish Commission.

Largemouth bass management in Tennessee reservoirs has followed the same evolution as that of the rest of the country over the last 50 years. Initial efforts during the 1950's and 1960's were aimed at enhanced harvest and yield through a minimum of harvest restrictions (Redmond 1986). During this period, many of the state's reservoirs were undergoing surges in productivity commonly observed in the first decade after impoundment, and fish populations were considered underutilized and unexploitable resources (Eschmeyer 1945; Parsons 1957).

As largemouth bass fishing pressure increased and reservoirs began to age during the 1970's, biologists began to observe the first evidence of declines in fish stocks (Redmond 1986). Additionally, bass anglers began to distinguish themselves as a specialty angling group and competitive angling came to the fore. As fishing gear advanced, bass anglers became more effective at finding and catching bass. Bass fishing, in turn, experienced a surge in popularity which has continued to place more pressure on fishery resources into the 1990's (Figure 1). Largemouth bass management efforts by the TWRA began to focus on regulating harvest to provide the optimal bass population size structure while maintaining adequate abundance and growth rates.

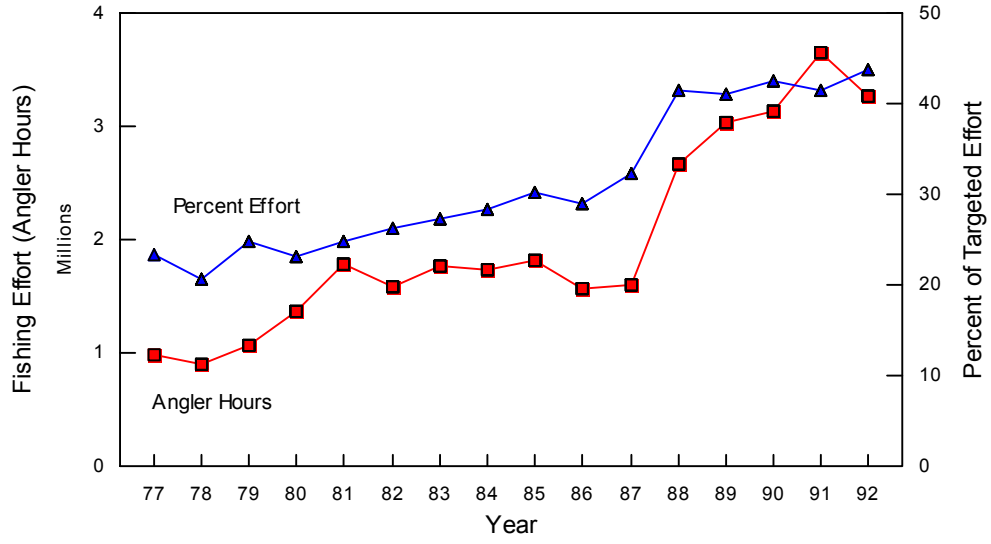

Figure 1. Statewide fishing effort for black bass species and percent of total targeted fishing effort comprised by black bass 1977-92.

The TWRA has operated and managed a series of small impoundments located in western and middle Tennessee since the late 1950's. These lakes were either bought or built by the agency to provide fishing opportunities in areas with limited access to reservoirs. TWRA fishing lakes are generally highly productive impoundments supporting panfish, catfish, and bass communities; however, most lakes are fertilized to boost productivity if deemed necessary by the managing biologist. Most TWRA fishing lakes are managed to provide large numbers of quality sized (12 - 15 inches) bass, although a few are managed with high length limits or slot limits to provide the potential for catching larger bass.

Annual fish population assessments are performed on reservoirs and TWRA fishing lakes. Largemouth bass stocking strategies and harvest restrictions are implemented upon recommendations by biologists performing fishery assessments on a given body of water. Daily creel and length restrictions have proven to be TWRA's most effective means of maintaining sustained yield for largemouth bass in reservoir systems and state-managed lakes.

Primary Objectives in Largemouth Bass Management

Program Objective: To maintain or improve the fishing experience for largemouth bass in Tennessee reservoirs.

Reservoir Productivity

Tennessee impoundments represent a wide diversity of largemouth bass production potentials. These inherent differences in system productivity necessitate the use of a 3-tiered system of trophic status in defining management options for bass. Classification is based on ecoregion, size, depth, water quality, and watershed fertility. Due to a lack of consistency in the collection of chlorophyll-a and nutrient data across the state, criteria for classification generally follow the recommendations of Denton et al. (1996). Where data were conflicting, final categorical decisions were made by regional TWRA biologists based on the relative productivity of specific fisheries.

Class A-High Productivity:	Barkley, Cherokee, Cheatham, Chickamauga, Douglas, Kentucky, Normandy, Old Hickory, Pickwick, Watts Bar, Reelfoot, some TWRA-managed lakes.
Class B-Medium Productivity:	Boone, Center Hill, Cordell Hull, Ft. Loudoun, Guntersville, Melton Hill, Nickajack, Percy Priest, Tims Ford, Woods, some TWRA-managed lakes.
Class C-Low Productivity:	Calderwood, Chilhowee, Dale Hollow, Ft. Patrick Henry, Great Falls, Norris, Ocoee Nos. 2 and 3, Parksville, South Holston, Tellico, Watauga.

Reservoir productivity drives the diversity and abundance of animals in aquatic communities. Productivity also defines the ecology of largemouth bass in the system. Low productivity systems (many tributary impoundments and a few mainstem impoundments) generally have lower shad biomass which may lessen "top-down" pressure on the reservoir's zooplankton resource. Higher plankton densities provide an abundant food source for larval bass, thus enhancing first year recruitment. However, intraspecific competition for both food and space often lead to slow growth, which may lead to high natural mortality rates in cooler upland impoundments, especially during harsh winters. Growth of adult bass may also be slowed causing overharvest of intermediate sized fish before they can reach sizes preferred by anglers. Protected length ranges (PLRs) or slot limits are often the most effective means of regulating largemouth bass fisheries in these impoundments (Class C) since they allow harvest of excessive numbers of recruits while protecting intermediate size fish until they exceed the protected range. PLRs with high upper limits may also be recommended for Agency lakes when management for trophy bass is desired.

Highly productive systems (many mainstem and a few tributary reservoirs) typically have a higher shad biomass and lower plankton densities. This scenario coupled with physical habitat limitations (variable flows, poor spawning habitat, etc.) usually causes these impoundments to experience lower first year recruitment rates and more variable recruitment among years. Although larval bass survival may be limited by low plankton densities, survival of stock size and larger fish is usually high due to the abundant shad forage base and fast growth rates (Allen et al. 1999). Minimum length limits are most appropriate for these reservoirs (Classes A and B), because recruitment is low and growth is not limited. Young bass are protected from harvest, ensuring adequate adult stocks even when several years of low recruitment occur.

Criteria for Harvest Restrictions

Largemouth bass harvest restrictions may be proposed or modified annually by TWRA biologists. Proposals must be based on data suggesting that the new regulation will produce a predetermined response within a largemouth bass population. These data are based on estimates of life function values for recruitment, growth, and mortality which are obtained from analysis of annual sampling efforts. These three rate functions vary between locations and years, but may follow predictable trends within reservoir or lake type. Similarities in these factors may also be observed within a given watershed or ecoregion. Standardized sampling protocols and maintenance of a statewide database ensure that comparisons can be made. The following describes the determination procedures:

<u>Recruitment</u>

Recruitment is defined as the number of largemouth bass surviving their first year of life. The number of annual recruits is important in formulating harvest restrictions because it serves as an indicator of what will ultimately become the harvestable portion of the population. Spring electrofishing catches of age 1 bass will be used to index the number of fish surviving their first winter. Management goals will be different for impoundments with consistently low, medium, or high bass recruitment, as well as those where variable year class success is observed.

Impoundments with consistent recruitment may be managed to maintain ranges of density, recruitment, and growth described in this plan (Table 1). High variability in mean catch rates of age 1 bass for an impoundment will require more careful evaluation before management strategies are implemented.

Growth

Growth is defined as an increase in fish length over time. Changes in weight have been used to describe growth, but increases in average length are normally the least variable and easily measured. Mean length at age 3 is normally the age when most largemouth bass enter the fishery, and is used to determine whether suitable growth exists. Otoliths are collected from a subsample of fish and age classes (e.g., age 1, age 2, etc.) are assigned by counting the number of annuli (rings). The number of fish in each age class in the subsample is then extrapolated to the entire bass sample. Year classes are assigned to age classes, and a mean length at capture can then determined for each year class (e.g. 1996 year class = all fish hatched during that calender year).

Mortality

Total mortality is determined for a bass population by analyzing declining catch through increasing age. These catch curves are used to determine the average rate of mortality across all ages for those fish fully recruited to the sampling gear (Ricker 1975). Total mortality can be separated into angling mortality (exploitation) and natural mortality (disease, starvation, predation, old age) components.

Angling mortality can be evaluated through angler (creel) surveys or, less commonly, through tagging studies conducted by TWRA biologists. When tagging studies are used, natural mortality may be determined by subtracting the estimate of exploitation (proportion of tags returned to initial number of bass tagged) from the estimate of total mortality (catch curve). Angler (creel) surveys are conducted annually by the TWRA on many of Tennessee's major reservoirs and periodically on state-managed lakes. These surveys provide insight into fishing mortality for largemouth bass via direct estimation of fishing effort, catch, and harvest. Angler surveys allow direct evaluation of the impact of harvest restrictions and their effects on the angling community. Tagging studies may be undertaken periodically on impoundments with no angler survey.

Stock indices such as proportional stock density (PSD) and relative stock density (RSD) may also be used as rough indicators of total mortality. These indices can allow biologists to observe the effects of overharvest over several size ranges in the fishery. However, use of stock indices to evaluate mortality must be performed in concert with catch curves and angler survey data since the index values can be biased by sampling conditions.

Implementing Harvest Restrictions

Program Objectives: To use length restrictions (minimum length and slot limits) to improve abundance and size structure of largemouth bass populations, and to provide a higher quality fishing experience.

The purpose of harvest restrictions is to protect fish populations from overexploitation while creating conditions favorable for promoting quality fisheries. While creel limits may be effective for distributing the catch among anglers, size limits are employed to maintain favorable fish populations, community structure, and quality fishing (Noble and Jones 1993).

The current statewide daily creel limit of 5 black bass per day in any combination should be effective in protecting largemouth bass stocks from overexploitation given current fishing pressure. Current levels of catch and release are considered high in most reservoirs, and it has been assumed that overall mortality on fish released immediately after capture is minimal. The objective of equitable harvest through daily limits of largemouth bass is probably achieved since incidence of catch and release tends to be higher among anglers targeting largemouth bass (Wilde and Ditton 1994). Daily creel limits may be reduced (high mortality) or increased (high density) on a case by case basis when problems with bass population abundance are suspected.

The objective of minimum length limits and PLRs are to increase abundance of bass in a population and improve size structure to provide a higher quality fishing experience. These two types of length limits are appropriate management strategies in most public waters, and most of those proposed by TWRA (e.g., 13 through 16 inch minimum length limit or several versions of PLRs) are aimed at increasing numbers of quality size fish rather than trophy size fish. However, when fishing mortality is high, both length limit types should result in more and larger fish for anglers. Fish community composition and bass population dynamics will be thoroughly evaluated for large reservoirs and agency lakes before new regulations are proposed.

Minimum length limits have their greatest impact in reservoirs where bass recruitment rates are lower and more variable between years. Several state agencies including TWRA have found that length limits have been highly effective in increasing bass density and shifting the harvest to larger and older fish. Since natural mortality is generally lower for older fish, length limits tend to stabilize bass populations and attenuate the effects of poor year classes. Anglers are less likely to observe dramatic shifts in fishing quality when a poor year class moves through the fishery.

PLRs are more effective in impoundments where bass recruitment is high (see following table). Harvest of smaller bass is needed in these impoundments to allow some fish to grow to larger sizes. Intermediate sized bass are protected so that they can recruit in higher numbers to sizes above the PLR, thus providing a higher quality fishery. Although state lakes are highly productive, bass recruitment is usually high and PLRs may be effective when managing for balanced populations or for trophy bass.

The TWRA fisheries management staff determines optimal management strategies for largemouth

bass population based on angler surveys, population surveys, and public input. Survey data are supplemented by the review of literature reporting national trends in factors affecting angler satisfaction. The following qualitative criteria were listed by Novinger (1984) for minimum length and PLRs for bass populations with the following characteristics:

Minimum Length Limits

1. Low recruitment
2. Moderate to fast growth
3. Low natural mortality
4. Moderate to high fishing mortality

PLRs

1. High recruitment
2. Moderate to slow growth
3. High natural mortality on young (age 0-2) bass
4. Moderate to high fishing mortality

TWRA biologists have quantified these criteria into target ranges for density, recruitment, growth, and mortality for each reservoir class (Table 1). Largemouth bass density ranges are based on spring electrofishing conducted by TWRA biologists under standardized sampling guidelines (1994-97).

Special regulations for reservoirs should be incorporated into reservoir management plans. Regional field staff must provide strong justification for proposal of new length limits based on field data and public opinion surveys. Computer simulation models (FAST) will be used when possible to evaluate options and support recommendations. Management objectives for the proposed length limit (e.g. justification of 14 to 18 inch PLR - encourage harvest of surplus recruits and increase numbers of largemouth bass above 18 inches) should be presented for proposed length limits in annual reservoir or agency lake management reports.

New reservoir and agency lake length limits will be officially proposed at the annual May fisheries biologists meeting, developed at regional staff meetings, and finalized at the August Director's Field Staff meeting. After presentation to the Tennessee Wildlife Resource Commission (TWRC) in August, the proposed recommendations will be released to the public for comment during September and October. Final recommendations, including Commission and public comments, will be presented to the TWRC at their October meeting. Exceptions to statewide standards may be considered on a case by case basis.

Table 1. Management Objectives for largemouth bass density, recruitment, growth, and mortality" on three classes of Tennessee impoundments. **Biologists may propose changes in harvest restrictions(daily creel and/or length limits) for populations with values falling outside the specified lake class ranges with proper justification**.

Parameter	Impoundment Class	Parameter Range
Density[1]	Class A	"50-100 bass ($8"")/hr. spring electrofishing"
		Catch >0.5 bass/angler-hour (directed effort)
	Class B	"50-100 bass $8"")/hr. spring electrofishing"
		Catch 0.3-0.5 bass/angler-hour (directed effort)
	Class C	"25-50 bass ($8"")/hr. spring electrofishing"
		Catch <0.3 bass/angler-hour (directed effort)
[1]ranges approximate 25th and 75th percentiles for catch rates from Tennessee reservoirs recorded between 1994 and 1997.		
Recruitment[2]	Class A	>30 Age 1 bass/hr. spring electrofishing
	Class B	11-30 Age 1 bass/hr. spring electrofishing
	Class C	0-10 Age 1 bass/hr. spring electrofishing
[2]catch rates of bass <203 mm (8 inches) may be substituted to index recruitment when age data are not available.		
Growth	Class A or B	330-355 mm (13-14 inch) at Age 3
	Class C	279-330 mm (11-13 inches) at Age 3
Mortality	All Classes	20-40% from Catch Curve
Size Structure Quality	All Classes	PSD: 50-70% with shad 40-60% without shad RSD-Q: 20-40% with shad 15-30% without shad
Minimum Exploitation	All Classes	$25%

Secondary Objectives in Largemouth Bass Management

Trophy Bass Lake Management

Program Objectives: To provide fishing opportunities for large bass in carefully selected impoundments.

Due to the increased public interest and demand for trophy largemouth bass in the southern United States and the success of trophy management in other states, TWRA will use biological data to review the feasibility of managing for trophy fisheries in some reservoirs and agency lakes (Mike Armstrong, AR Game and Fish Commission, personal communication; Gene Gilliland, OK Department of Wildlife Conservation, personal communication; Steve Poarch, TX Parks and Wildlife Commission, personal communication; Kelly 1998).

The Agency's objective through trophy management will be to promote conditions favorable to producing fish larger than 5 lbs. and increased catch of fish exceeding 8 lbs.. Strong public interest has been demonstrated in Tennessee with 68% of reservoir anglers interviewed in TWRA's annual phone survey supporting trophy bass management in some waters (Jakus et al. 1999). Once an impoundment is identified as a potential site for trophy management, public input must be gathered and evaluated. Reservoirs with fish consumption advisories may be particularly good candidates since harvest mortality tends to be low for these populations (Jakus et al. 1998).

The final step will be the presentation of a lake or reservoir management plan to the Tennessee Wildlife Resources Commission (TWRC) for review and acceptance. It must be understood by all resource stakeholders that even when ideal conditions appear present for trophy largemouth bass management in a given impoundment, expectations may not always be met due to a variety of unforseen factors. Management for larger sized fish may also come at the expense of decreased catch or harvest rates for that impoundment.

A reservoir or lake must meet the following broad criteria to be considered for trophy management:

1. Public acceptance of trophy bass management plan
2. Moderate to high bass productivity
3. Consistent bass recruitment
4. Fast bass growth
5. Productive shad populations with dependable year-classes

Specific requirements include:

1. Mean Age 1 CPUE of 20 - 30 bass per hour during spring electrofishing samples (for a minimum of 5 years)
2. Mean length at Age 3 > 14 inches
3. Multi-modal size class distributions of shad (spring electrofishing for a minimum of 5 years)
4. Average less than 200 hrs/ 5 lb. bass in B.I.T.E. tournament summaries (reservoirs)

Secondary indicators of potential success include:

1. PSD of 50 - 70%
2. RSD-P of 30 - 40%
3. RSD-M > 10%
4. Mean total CPUE of 75 - 100 largmouth bass ≥ 8 inches per hour during spring electrofishing
5. CPUE between 15 - 40 bass per hour ≥ 15 inches
6. Impoundment suitable for Florida bass introduction (based on heating degree days)

Management Strategy:

Trophy bass management takes advantage of an impoundment's potential for producing large fish. The following strategies will be used in any combination to promote the production of trophy sized largemouth bass:

1. *Restricted harvest* - A 16 to 22 inch protective slot limit with a daily creel of 4 bass under and 1 bass over the protected slot.
2. *Florida bass introduction* - will be stocked at rate of 10 per acre for a period of 5 years or until Florida bass genes constitute >15% of the population's gene pool.
3. *Forage introduction* - Threadfin and gizzard shad introductions will be conducted where needed to diversify the forage base.
4. *Fertilization* - Will be used only on state managed lakes less than 500 acres in size, with hydraulic retention times exceeding 1 year, and total hardness values exceeding 20 mg/l $CaCO_3$.

Florida Largemouth Bass Stocking Policy

Managing for trophy largemouth bass through largemouth bass introduction is not a new strategy in the United States (Chew 1975). Lower vulnerability to angling, faster growth (during adult stages), and greater maximum size have all been cited as rationale for stocking programs in other states (Pelzman 1980; Zolczynski and Davies 1976). Broad public support for Florida bass stocking in Tennessee has been driven by the success of Florida bass programs in Alabama, Arkansas, California, Texas, Mississippi, Louisiana, and Oklahoma. Fisheries management agencies in these states have determined that catches of record sized bass have increased in many lakes receiving Florida bass, and that most of the record fish caught were pure Florida bass or contained a high proportion of the Florida genome (unpublished TWRA survey). A recent study in Alabama reservoirs indicated that the percentage of Florida bass alleles present in populations was the only controllable variable that could influence catch rates of memorable sized bass (Hendricks et al. 1995). The TWRA feels that Florida bass stocking could enhance fishing quality in Tennessee, since the state is located at a latitude with environmental conditions similar to other states where Florida bass stocking has been successful (Arkansas, Oklahoma, and Texas).

Due to controversy in some states surrounding the stocking of Florida subspecies largemouth bass, the TWRA will be conservative in making recommendations for recipient bodies of water. Philipp (1982) in his national survey of largemouth bass genetics identified Tennessee as the

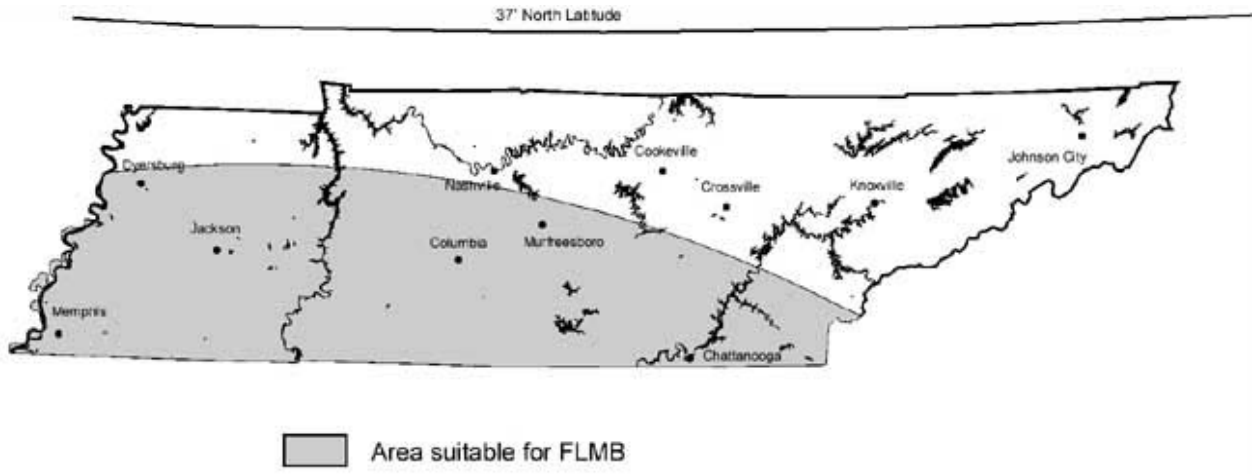

Figure 2. Portion of Tennessee deemed suitable for Florida largemouth bass (FLMB) stocking based on latitude and heating degree days.

southern limit of the natural range for northern subspecies largemouth bass. This assertion was drawn from extrapolation of range limits for the species since few Tennessee populations were sampled for that study. A statewide survey conducted during the late 1980's indicated that virtually all reservoir and agency lake populations contained some Florida genes, probably due to unsanctioned introductions (O'Bara et al. 1993).

Controlled introductions of Florida bass will be undertaken to increase the proportion of Florida genes in populations with identified potential for trophy management. Compromising the genetic integrity of existing bass stocks is not anticipated since no populations of the pure northern subspecies currently exist in Tennessee. Undesired migration of Florida bass into lentic (stream and river) systems has not been observed in other states, likely due to the evolutionary history of the subspecies in south Florida lakes (Maceina et al. 1988).

Management with Florida bass will initially be limited to agency lakes and embayments in reservoirs. Recent studies have indicated that embayments in reservoirs may be characterized as subimpoundments that can be managed for specific largemouth bass objectives independent of other areas (Noble et al. 1994). Because success of Florida bass introductions appears dependent on local environmental conditions, only agency lakes and reservoir embayments south of the 37 degree parallel with heating degree days < 1900 will be considered for Florida bass introduction (Figure 2)(Hoover et al. 1998; Gene Gilliland, personal communication; Maceina et al. 1988).

All lakes where stocking occurs will be monitored annually to determine the proportion of Florida genes present. Stocking will be repeated annually for up to 5 years or until Florida bass genes comprise at least 15% of a population's genome. If Florida genes do not contribute more than 5% of a population's genetic structure after 4 years, stocking will be re-evaluated at that location. TWRA will attempt to obtain or produce 3 - 4 inch fingerlings which can be stocked before a population's natural spawn in order to maximize the potential for introgression. Stocking rates may vary from year to year based on availability but should be a minimum of 10 fish per surface acre. When fingerling numbers are limited, priority for stocking will be given to locations where Florida genes are present in high percentages or where trophy bass production has its highest potential.

Tournament Fishing

Program Objectives: To work cooperatively with competive anglers to protect and enhance largemouth bass resources.

Organized tournament fishing is an important component of reservoir fisheries in Tennessee. Recent telephone surveys indicate that up to 10% of Tennessee anglers fish in tournaments each year and up to 5% belong to fishing clubs (Fly et al. 1997). The vast majority of tournaments and fishing clubs in Tennessee are dedicated to the pursuit of largemouth bass. National tournament organizations host several invitational tournaments each year which draw anglers from across the nation, providing high visibility for Tennessee's reservoir fisheries.

While tournament anglers can bring thousands of dollars in revenue to local economies during competition, they potentially have significant effects on largemouth bass resources. Summer

tournament mortality has been cited as a significant cause of largemouth bass mortality in several studies (Plumb et al. 1988; Taylor 1990; Schramm et al. 1991) . Weathers and Newman (1997) found that the use of several organizational procedures during summer bass tournaments significantly reduced mortality during and after weigh-ins in Alabama. Most important of these procedures was adequate water quality in boat livewells and recovery tanks, sufficiently low air temperature during weigh in (< 90 degrees F), low numbers of anglers weighed in during 30 minute intervals (< 50), and expedience of weigh-in (shorter holding times are better).Flow-through boat livewells containing greater than 6 ppm oxygen have also been found to significantly reduce tournament post-release mortality (Gilliland 1997a).

A recent study found that delayed and total mortality rates reported for tournament caught bass during the 1990s were not significantly different from those observed during the 1980s (Wilde 1998). This finding suggests that recommendations made by fisheries researchers have not been heeded or utilized by tournament organizers. The same study indicated that tournament-related mortality caused most delayed mortality and could be reduced by practices such as: 1) restricting or prohibiting fishing gears that can be swallowed deeply or otherwise injure fish during hooking, playing, and landing; 2) restricting numbers and types of tournaments held during warmer months; 3) reducing stress on larger fish by encouraging early weigh-in and release; 4) adopting alternatives to traditional weigh-in procedures (i.e. fish are caught, photographed or measured, and immediately released). Although the TWRA has not established criteria or regulations requiring any of these procedures, bass tournament administrators are strongly encouraged to incorporate them when organizing bass fishing events.

Problems

1. *Post-release mortality* - Most organized bass fishing events endorse catch and release. However, recent studies indicate that overall tournament mortality rates range from very low to as high as 60% for released fish, and mortality is especially high during the summer months (Shramm et al. 1991a). Fishing tournament participants must abide by TWRA's daily catch limits which are designed to prevent depletion of quality sized bass. Most tournament organizers are committed to live release of bass, but must continue refining their techniques to promote survival.

2. *Displacement of fish* - Tournament weigh-ins are generally held at boat ramps where fish are weighed and held in recovery tanks prior to release. Largemouth bass have a tendency to remain close to where they were released, which may impact densities in other parts of the reservoir and cause higher potential for competition near the release site (Stang et al. 1996; Healey 1990).

3. *Conflict with other user groups* - Approximately 10% of anglers interviewed in the TWRA's annual phone survey complained of interference with tournament anglers (Fly et al. 1997). Tournament anglers can greatly reduce ramp and parking space at departure points, making it difficult for other users to access the reservoir. Many of these problems are compounded by increasing numbers of reservoir users competing for inadequate numbers of access facilities with insuffient funding for maintenance and expansion (National Recreation Lakes Study Commission 1999).

4. *Increased demand on TWRA Fisheries personnel* - Agency personnel are often requested to assist tournament anglers at weigh-in sites. Hatchery tank trucks may be requested to hold fish or aid in fish transport back to the water if weigh-ins are held away from the reservoir. Due to the limited number of biologists and hatchery personnel available, TWRA's official policy is to limit this type of participation to the largest tournaments where potential for bass mortality is the high. Only tournaments with remote weigh-in sites (away from the lake) will be considered. Agency participation requires approval from the Executive Director of TWRA.

Benefits

1. *Data collection opportunities* - TWRA biologists and university researchers have used tournaments to collect data for surveys and studies. Tournament data have proven to be a valuable resource, especially when used to supplement other datasets (Holbrook II, 1975; Gabelhouse and Willis 1986). TWRA's annual B.I.T.E. (Bass Information from Tournament Entries) Report summarizes bass tournament catch and fishing success across the state from data provided voluntarily by fishing clubs. Eighty-six clubs have participated in this program and contributed 548,290 angler-hours of data since its inception in 1989 (B.I.T.E. 1997).

2. *Promotion of sportfishing and conservation ethics* - Tournament angling organizations have a high degree of visibility to the public through newsletters, magazines, and television programs. These organizations promote the sport of freshwater fishing and were among the first to promote catch and release of warmwater species. Bass clubs have also encouraged family involvement in the sport of fishing by sponsoring kid's fishing events.

3. *Tournaments benefit local economies and TWRA* - Recent socioeconomic surveys indicate that large tournaments can bring millions of dollars into local economies during a single two-day event. Visitors attending the 1996 BASS Masters Classic injected an estimated $15.1 million into the Birmingham, AL area (Green 1997). Most tournaments are much smaller, but are able to positively impact economies through food, fuel, and lodging expenditures. Tournament anglers also drive the market for high-end sportfishing tackle, boats, and motors. Purchase of these items supports the excise taxes that support Federal Aid in Sportfish Restoration; the primary funding source for TWRA's fisheries programs. Media coverage of tournament events in Tennessee provides additional economic benefit through exposure of the state's fishing resources and tourist attractions (Bryan 1995).

4. *Fishing organizations provide funding and assistance for fisheries projects* - Fishing clubs have provided valuable assistance to TWRA's fishing programs. They have been especially active in assisting the Agency's biologists in habitat improvement and restoration. Shoreline enhancement and stabilization projects through tree and grass plantings as well as the agency's fish attractor program rely on volunteer from fishing clubs. Fishing clubs also sponsor kids fishing programs such as rodeos, derbies, and other events held throughout the year.

Status of TWRA's Competitive Fishing Policy

1. *Fishing tournaments are a legitimate use of the state's bass resources and currently do not require special regulations or use restrictions*. The effects of tournament fishing on bass resources are unknown, although there is no evidence suggesting that they have caused stock depletion in any of the state's waters. Competitive anglers are subject to TWRA fishing regulations just as non-competitive anglers, and event regulations are often even more restrictive than the Agency's. Tournament anglers account for a minor proportion of overall bass fishing effort. However, problems arising from access point congestion during tournaments may someday reach the level where the Agency will need to regulate tournaments through permitting.

2. *Continue to promote the live release of tournament caught bass*. Tournament anglers have the right to keep (harvest) fish under the same regulations as non-competitive anglers. However, most tournaments require the live release of all bass by participants. The TWRA endorses this effort by competitive anglers to conserve bass resources. The Agency also appreciates the influence that this practice has had on other angler groups and encourages competitive event sponsors and participants to educate themselves on methods that enhance fish survival. It is vital that competitive anglers implement the best methods for live release at all tournaments and release fish at several points away from the weigh-in site.

3. *Promote further direct involvement of TWRA personnel in major organized fishing events*. The Fisheries Management Division will continue to encourage biologists to maintain a presence at major competitive angling events and club meetings. Our biologists can enhance the Agency's visibility to this user group while working with clubs to enhance survival of tournament catch. Continued involvement will open the door to further data collection opportunities and enhance an atmosphere for greater understanding and communication between resource stakeholders (Schramm et al. 1991b).

4. *Continue to develop, promote, and utilize the Bass Information from Tournament Entries (B.I.T.E.) program*. The B.I.T.E. program is a voluntary program that promotes a closer relationship between the TWRA and bass clubs through the exchange of tournament data. The annual report summarizes catch data submitted by clubs and serves as a fisheries management tool for the agency. The report serves the clubs with a statewide summary of tournament results for their interest and possible use in tournament site selection. Interaction between clubs and the TWRA through the program maintains open communication with anglers. The TWRA will continue to encourage clubs to participate in the B.I.T.E. program, and work with the Tennessee B.A.S.S. Chapter to require mandatory support by its clubs.

Habitat Improvement and Restoration

Reservoir environments are known for their variability on spatial and temporal scales (Ploskey 1986). Physical differences in shoreline and basin characteristics, changes in water level, and vegetation all can greatly affect fish community dynamics and spawning success in reservoirs (Kohler 1993; Irwin and Noble 1996; Wrenn et al. 1996). These variables are driven by power, navigation, and flood control demands and are controlled by agencies administrating the dams. TWRA will continue to work with these regulators to improve spring water levels management and provide optimal spawning conditions for largemouth bass and other warmwater fish species. TWRA biologists will continue to promote partnerships with the U.S. Army Corps and

Tennessee Valley Authority (TVA) personnel in monitoring water quality for the well being of reservoir fish communities. Continued interagency coordination will occur to promote quality bass habitat and construction of ramp facilities for angler access.

Largemouth bass and other fishes can be affected by aquatic vegetation abundance, both directly and indirectly. Optimal vegetative cover promotes bass survival and growth and may have affects on forage abundance (Bettoli et al. 1992, 1993). However, heavy macrophyte coverage can negatively affect fishing success by providing more refugia for bass and decreasing angling vulnerability (Maceina and Reeves 1996). Furthermore, when macrophytes are extremely abundant, bass growth can also be negatively affected bass growth due to reduced foraging efficiency (Bettoli et al. 1992).

Macrophytes have been historically scarce in most Tennessee reservoirs due to fluctuating water levels and nearly all attempts to establish submersed macrophytes or shoreline vegetation have met with little or no success. It is the policy of TWRA to avoid controlling aquatic macrophytes unless their occurrence creates substantial negative impacts on other uses of these multi-purpose impoundments. TWRA also recognizes that macrophyte coverage in the few reservoirs where it occurs is driven by natural hydraulic factors (droughts or floods) much more than any attempts to control or enhance growth.

Controversy among bass anglers and other user groups has centered around the control exotic vegetation such as Eurasian Watermilfoil and Hydrilla. At present, TWRA only conducts weed control at Reelfoot Lake via contract spraying of herbicide and grass carp stocking. Other regulating agencies (i.e., TVA and U.S. Army Corps of Engineers) are no longer practicing weed control in Tennessee impoundments. All current weed control in reservoirs is conducted by commercial sprayers contracted by private citizens or municipalities These activities are allowed under a permit system administrated by the Tennessee Department of Environment and Conservation (TDEC). Permits are granted only for areas necessary for boat traffic and immediately around docks.

TWRA biologists will continue work with regulating agencies to develop aquatic plant management plans that favor the establishment of native plants that can benefit fish habitat and fishing. The Agency will also continue to promote the reduction of winter draw-downs to favor growth and expansion of plant communities within manageable limits. Development of management plans will focus on providing optimal vegetative coverage to promote growth and survival of young bass while maintaining current levels of fishing success.

Resource and Program Needs and Impediments:

The accuracy and precision of TWRA's data will be the foundation of the agency's decision making. Improvements in reservoir survey procedures have been recently standardized and outlined in a field manual (TWRA 1998). Standardization of fishery collection procedures for state managed lakes is scheduled in 1999. After all standardization is complete, data will be

compiled into databases which will be used to analyze different, comparative management scenarios for largemouth bass across the state (National Freshwater Fisheries Database Summit 1998).

Fisheries Management

The effectiveness of TWRA's largemouth bass management plan will depend on new efforts and improvements in the agency's hatcheries and management survey protocols. New, applied research will also be needed to address problems encountered in managing largemouth bass populations. Funded research and the agency's management goals will be guided by the needs and objectives outlined in this plan. Human resources and funds will need to be allocated to the following areas in order to realize this plan's objectives:

1. *In-service and technical training in data analysis* - Fisheries staff will require review in calculating common indices and measures of precision used in fisheries management. Additional training will be required in interpretation of data and trend analysis.

2. *Review of angler survey designs and procedures* - Creel survey designs must be evaluated to ensure that accurate and precise information is gathered for largemouth bass catch, harvest, and fishing effort.

3. *Continue to monitor angler attitudes and preferences* - TWRA must continue annual review of what constitutes quality largemouth bass fishery across the state. Localized attitude surveys and/or public hearings will be required when an impoundment is determined to have trophy bass potential.

Hatchery and Fish Culture

TWRA has five hatcheries dedicated to the production of warmwater and coolwater species. Due to high demands for walleye, striped bass, and crappie, pond space is limited in all of these facilities. A limited number of largemouth bass are produced each year for stocking ponds, state managed lakes, and state park lakes.

4. *Hatchery production of Florida bass* - Increased demand for hatchery space is expected as the number of lakes managed for trophy fisheries increases. A demand of at least 500,000 fingerlings per year is expected. Funding for additional ponds will be required and research will be needed to produce fingerlings that can be stocked prior to natural bass spawns in recipient impoundments.

Research

Research grounded in the agency's fisheries management practices will answer questions about the validity of our largemouth bass survey methods, and improve our effectiveness at achieving bass management objectives.

TWRA's research program answers critical questions required for the proper management of Tennessee's fisheries. The following are research topics and objectives that need to be addressed to attain the goals outlined in this plan.

5. *Evaluate and develop Florida bass stocking and management guidelines for Tennessee*.
Need: Introductions of Florida bass may provide higher trophy potential for some waters due to their capacity to grow to larger sizes. Stocking plans for this subspecies of largemouth bass are needed.
Objective: To establish a long term genetic inventory of reservoirs and agency lakes which will determine the extent of Florida bass introgression from previous stockings and aid in predicting the success of future stockings. This study will guide managers in decisions about where to stock for the most efficient use of available Florida bass.

6. *Monitor and adjust the largemouth bass harvest restrictions and trophy lake criteria identified in this plan*.
Need: Criteria used to determine the suitability of lakes and reservoirs for trophy management was based upon data from other states at similar latitudes. Tennessee must evaluate and develop these criteria through evaluation of annual creel survey data and as data collected using standardized sampling methodologies becomes available (Wilde 1997).
Objective: To determine if criteria described in this plan are effective in determining the suitability of reservoirs and agency lakes for adjustment of harvest restrictions or trophy bass management. Develop individual models of bass population dynamics that allow informed decisions on implementation of new restrictions.

7. *Evaluate the effectiveness of stocking young-of-year bass to supplement natural reproduction and year class abundance*.
Need: Young-of-year bass are stocked by TWRA to supplement year class strength and reproduction in many different classes of state waters. The agency must determine the effectiveness of these stockings in different impoundment types and which sizes of stocked bass have the highest survival rate (Bettoli 1997; Churchill et al. 1995; Boxrucker 1986).
Ojective: To evaluate survival of stocked largemouth bass and their ability to enhance year classes in reservoirs. Determine if stocking fish at larger sizes increases survival and is logistically and economically feasible for the agency.

8. *Determine the effects of competitive bass fishing on the harvest, displacement, and spawning success of largemouth bass*.
Need: Although most competitive angling events require live release, high numbers of fishing tournaments conducted on the same body of water during a given year may affect bass populations (Gilliland 1997b). Studies are needed to evaluate how tournaments affect bass catch rates, distribution in the reservoir, and reproductive success. The TWRA needs to document the status of fish care during tournaments both in boats and at the weigh-out (Gene Gilliland, personal communication).
Objective: Determine the response of bass populations to different levels of tournament activity.

9. *Evaluate habitat enhancement projects to determine their effects on largemouth bass population density and accessibility to anglers*.
Need: TWRA has and will continue to conduct habitat enhancement in the state's waters. Evaluation of shoreline enhancement, aquatic vegetation management projects, and fish attractors is vital to ensure that they are functioning to meet the agency's fishery management objectives.
Objective: Studies are needed to A) determine the potential of introducing native aquatic vegetation that can be utilized to enhance bass habitat, B) determine if attractor devices increase angler success and satisfaction, C)determine what attractor designs and materials are most effective at attracting bass, and D) determine if shoreline plantings enhance bass recruitment by providing nursery cover.

10. *Increased funding is required for bass management research* - The TWRA is mandated as a natural resource management agency, but currently has no research biologists on staff. The agency must solicit proposals from universities in order to conduct research in areas of concern for fisheries management. This arrangement is by far the most economical way to answer specific, scientific questions required to effectively manage largemouth bass in Tennessee waters. The current level of funding for bass research must be increased in order to evaluate and refine harvest restrictions and trophy management objectives outlined in this plan.

Literature Cited

Allen, M..S., J.C. Greene, F.J. Snow, M.J. Maceina, and D.R. DeVries. 1999. Recruitment of largemouth bass in Alabama reservoirs: relations to trophic state and larval shad occurrence. North American Journal of Fisheries Management 19:67-77.

Bettoli, P.W. 1997. Supplemental stocking of largemouth bass into two Tennessee reservoirs. Technical Report 97-4. Tennessee Wildlife Resources Agency. 20 pp.

Bettoli, P.W., M.J. Maceina, R.K. Betsill, and R.L. Noble. 1992. Piscivory in largemouth bass as a function of aquatic vegetation abundance. North American Journal of Fisheries Management 12:509-517.

Bettoli, P.W., M.J. Maceina,R.L. Noble, and R.K. Betsill. 1993. Response of a reservoir fish community to aquatic vegetation removal. North American Journal of Fisheries Management 13:110-124.

Boxrucker, J. 1986. Evaluation of supplemental stocking of largemouth bass as a management tool in small impoundments. North American Journal of Fisheries Management. 6:391-396.

Bryan, H. 1995. Social and economic impact assessment of the 1993-94 BassMasters tournament trail. Technical Report. B.A.S.S., Inc., Montgomery, AL.

Chew, R.L. 1975. The Florida largemouth bass. Pages 450-458 in R.H. Stroud and H. Clepper, editors. Black Bass Biology and Management. Sport Fishing Institute, Washington D.C.

Churchill, T.N., R.L. Noble, J.E. Gran, and A.R. Alicea. 1995. Largemouth bass recruitment in Lucchetti Reservoir. Final Report, Federal Aid in Sportfish Restoration Project F-16. Puerto Rico Dept. of Nat. Res., San Juan.

Denton, G.M., C.S. Freeman, and K.A. Larrieu. 1996. The status of water quality in Tennessee 1996 305(b) Report. Division of Water Pollution Control. Tennessee Department of Environment and Conservation, Nashville, TN.

Eschmeyer, R.W. 1945. The Norris Lake fishing experiment. Division of Fisheries. Booklet. Tennessee Department of Conservation, Nashville, TN.

Fly, J.M., B. Stephens, and P.M. Jakus. 1997. Fishing and boating by Tennessee residents: a preliminary report about activities in 1994, 1995, and 1996. Draft Report. Human Dimensions Research Lab, Univ. of Tennessee. 24 pp.

Gabelhouse, D.W., Jr., and D.W. Willis. 1986. Bias and utility of angler catch data for assessing size structure and density of largemouth bass. North American Journal of Fisheries Management 6:481-489.

Gilliland, G. 1997a. Evaluation of procedures to reduce delayed mortality of black bass following summer tournaments. Oklahoma Dept. of Wildlife and Conservation. Final Report. Federal Aid in Sportfish Restoration Project F-50-F.

Gilliland, G. 1997b. Oklahoma bass tournaments, 1997 annual report. Oklahoma Dept. of Wildlife and Conservation Special Publication, Oklahoma City, OK.

Green, T.G., 1997. A social and economic impact assessment of the 1996 BASS Masters Classic, Birmingham, Alabama. Technical Report. B.A.S.S., Inc., Montgomery, AL.

Hoover, R.S., J.J. Ney, E.M. Hallerman, and W.B. Kittrell, Jr. 1998. Comparison of Florida, northern, and intergrade juvenile largemouth bass in a Virginia reservoir. Proceedings of the 1997 Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 51:192-198.

Irwin, E.R. and R.L. Noble. 1996. Effects of reservoir drawdown on littoral habitat: assessment with on-site measures and geographical information systems. Pages 324-331 in L.E. Miranda and D.R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society Symposium 16.

Jakus, P.M., J.M. Fly, B. Stephens, and D. Dadakas. 1999. Fishing and boating by Tennessee residents in 1997 and 1998. Agricultural Experimental Station. University of Tennessee, Knoxville, Tennessee. 33 pages.

Jakus, P.M., D. Dadakas, and J. M. Fly. 1998. Fish consumption advisories: incorporating angler-specific knowledge, habits, and catch rates in a site choice model. Staff Paper 98-03. Agricultural Experimental Station. University of Tennessee, Knoxville, Tennessee. 16 pages.

Jakus, P.M., J.M. Fly, B. Stephens, and R. Chewning. 1996. Fishing, hunting, and non-consumptive activities by Tennessee residents March - August 1995. Draft Report. Univ. of Tennessee. 31 pp.

Maceina, M.J. and W.C. Reeves. 1996. Relations between submersed macrophyte abundance and largemouth bass fishing tournament success on two Tennessee River impoundments. Journal of Aquatic Plant Management 34:33-38.

Maceina, M.J., B.R. Murphy, and J.J. Isely. 1988. Factors regulating Florida bass stocking success and hybridization with northern largemouth bass in Aquilla Lake, Texas. Transactions of the American Fisheries Society 117:221-231.

National Recreation Lakes Study Commission. 1999. Reservoirs of Opportunity. Final Report. National Recreation Lakes Study. Washington D.C. 145 pages.

Noble, R.L., J. R. Jackson, E.R. Irwin, J.M. Phillips, and T.N. Churchill. 1994. Reservoirs as landscapes: implications for fish stocking programs. Transactions of the North American Wildlife and Natural Resources Conference. 59:281-288.

Noble, R.L. and T.W. Jones. 1993. Managing fisheries with regulations. Pages 383-402 in C.C. Kohler and W.A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Novinger, G. D. 1984. Observations on the use of size limits for black bass in large impoundments. Fisheries 9:2-6.

Healey, T.P. 1990. Movement and survival of tournament-caught black bass at Shasta Lake. California Fish and Game. 76:36-42.

Hendricks, A.S., M.J. Maceina, and W.C. Reeves. 1995. Abiotic and biotic factors related to black bass fishing quality in Alabama. Lake and Reservoir Management 11(1):47-56.

Holbrook II, J.A. 1975. Bass fishing tournaments. Pages 408-415 in R.H. Stroud and H. Clepper, editors. Black Bass Biology and Management. Sport Fishing Institute, Washington D.C.

Kelly, J. 1998. Florida largemouth bass evaluation. Final Report. Federal Aid in Sportfish Restoration Project F-60-M.. New Mexico Department of Game and Fish. Santa Fe, NM. 14 pages.

Kohler, C.C., R.J. Sheehan, and J.J. Sweatman. 1993. Largemouth bass hatching success and first-winter survival in two Illinois reservoirs. North American Journal of Fisheries Management 13:125-133.

O'Bara, C.J. 1998. TWRA Creel Database 1990-1997. Tennessee Wildlife Resouces Agency, Nashville, Tennessee.

O'Bara, C.J., T.A. Hibner, K.D. Young, and E.R. Johnson. 1993. Largemouth Bass Genetic Study. Final Report. Federal Aid in Sportfish Restoration. Tennessee Wildlife Resources Agency. 62 pp.

Parsons, J.W. 1957. Fishery management problems and possibilities on large southeastern reservoirs. Transactions of the American Fishery Society 87:333-355.

Pelzman, R.J. 1980. Impact of Florida largemouth bass, *Micropterus salmoides floridanus*, introductions at selected northern California waters with a discussion of meristics for detecting introgession and for classifying individual fish of intergraded populations. California Fish and Game 66:133-162.

Philipp, D.P. and G.S. Whitt. 1982. Biochemical genetics of largemouth bass. Final Report. Electric Power Research Institute, Palo Alto, CA.

Ploskey, G.R. 1986. Effects of water-level changes on reservoir ecosystems with implications for fisheries management. Pages 86-97 *in* G.E. Hall and M.J. Van Den Avyle, editors. Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Southern Division, Reservoir Committee, Bethesda, Maryland.

Plumb, J.A., J.M. Grizzle, and W.A. Rodgers. 1988. Survival of caught and released largemouth bass after containment in livewells. North American Journal of Fisheries Management 8:325-328.

Redmond, L.C.. 1986. The history and development of warmwater fish harvest regulations. Pages 186-195 *in* G.E. Hall and M.J. Van Den Avyle, editors. Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Southern Division, Reservoir Committee, Bethesda, Maryland.

Ricker, W.E. 1975. Estimation of survival rate and mortality rate from age composition. pp. 29-73 in Computation and Interpretation of Biological Statistics of Fish Populations. Bulletin 191. Journal of the Fisheries Research Board of Canada, Ottawa, Canada.

Schramm, H.L., Jr., M.L. Armstrong, N.A. Funicelli, D.M. Green, D.P. Lee, R.E. Manns, Jr., B.D. Taubert, and S.J. Waters. 1991. The status of competitive sportfishing in North America. Fisheries 16(30):4-12.

Schramm, H.L., Jr., M.L. Armstrong, A.J. Fedler, N.A. Funicelli, D.M. Green, J.L. Hahn, D.P. Lee, R.E. Manns, Jr., S.P. Quinn, and S.J. Waters. 1991. Sociological, economic, and biological aspects of competitive fishing. Fisheries 16(30):13-21.

Stang, D.L., D.M. Green, R.M. Klindt, T.L. Chiotti, and W.W. Miller. 1996. Black bass movements after release from fishing tournaments in four New York waters. Pages 163-171 in L.E. Miranda and D.R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society Symposium 16.

Taylor, J.B. 1990. Post-release mortality and physiological stress responses in tournament-caught largemouth bass (*Micropterus salmoides*). M.S. Thesis. University of Tennessee. Knoxville.

TWRA, 1998. Reservoir Fisheries Assessment Guidelines. Fisheries Management Division. Tennessee Wildlife Resources Agency, Nashville, TN.

Weathers, K.C. and M.J. Newman. 1997. Effects of organizational procedures on mortality of largemouth bass during summer tournaments. North American Journal of Fisheries Management 17:131-135.

Wilde, G.R. 1998. Tournament-associated mortality in black bass. Fisheries 23(10):12-22.

Wilde, G.R. 1997. Largemouth bass fishery responses to length limits. Fisheries 22(6):14-23.

Wilde, G.R. and R.B. Ditton. 1994. A management-oriented approach to understanding diversity among largemouth bass anglers. North American Journal of Fisheries Management 14:34- 40.

Wrenn, W.B., D.R. Lowery, M.J. Maceina, and W.C. Reeves. 1996. Relationships between largemouth bass and aquatic plants in Guntersville Reservoir, Alabama. Pages 382-393 in L.E. Miranda and D.R. DeVries, editors. Multidimensional approaches to reservoir fisheries management. American Fisheries Society Symposium 16.

Zolczynski, S.J., Jr. and W.D. Davies. 1976. Growth characteristics of northern and Florida subspecies of largemouth bass and their hybrid and a comparison of catchability between the subspecies. Transactions of the American Fisheries Society 105:240-243.

Glossary

Biomass: weight of species or group of species expressed as pounds per acre or kilograms per hectare.

Catch-curve: a graph representing the relative abundance of various year-classes of a fish species. Used to measure total mortality effecting the various year-classes present in the population.

Chlorophyll a: a pigment found in green plants and algae used in limnology as a measure of primary productivity in a lake or reservoir system.

Ecoregion: geographic regions in Tennessee that contain similar land, water, and wildlife characteristics. Mississippi Alluvial Plain ecoregion, Blue Ridge Mountain ecoregion, Interior Plateau ecoregion, etc.

Exploitation: bass harvested or removed from the population by the fisherman. Measured using return of reward tags from a known number of tagged bass.

Florida bass: a subspecies of largemouth bass (*Micropterus salmoides floridanus*) native to the lower Florida peninsula. Desired for their ability to obtain relatively large sizes and advanced ages.

F_1 hybrid largemouth bass: a cross between northern strain and Florida strain largemouth bass.

Growth: change in fish length with time. Measured as the average length of the bass at its third year of age (mean length of Age 3 bass).

Interspecific competition: Competition between two or more species for food or space when (and only when) either is limited.

Memorable-Sized: Largemouth bass in the 20 - 25 inch length range. The size when become bass become memorable to catch.

Mortality: removal of fish from the population by death, either by natural causes or harvest by a fisherman. Total mortality is a combination of both factors and is indirectly assessed with Proportional and Relative Stock Density indices. Fishing mortality alone measured by exploitation studies or creel census surveys. Length and slot limits are designed to reduce fishing mortality on selected sizes of bass.

Northern largemouth bass: the subspecies of largemouth bass (*Micropterus salmoides salmoides*) native to Tennessee waters.

Preferred-size: Largemouth bass in the 15 - 20 inch length range. The size preferred by most bass fishermen to catch.

Proportional Stock Density: an index that expresses the proportion of quality-sized bass (12 inches and larger) to stock size bass (8 inches and larger). Used as an indirect measure of total mortality.

Quality-size: Largemouth bass in the 12 - 15 inch length range. The size at which most fishermen begin to keep bass.

Recruitment: number of fish spawned that live at least one year. Measured as the number of Age 1 bass in spring electrofishing or summer cove-rotenone samples.

Relative Stock Density: an index that expresses the proportion preferred-sized bass (15 inches and larger) to stock-sized bass (8 inches and larger).

Stock-size: bass between 8 and 12 inches. The Age 1 and Age 2 bass that will grow to replace larger bass that are removed by fishing or natural death.

Year-class: a population of bass spawned in the same year.

Appendix A

Comments from Public on draft of Bass Plan*
(Number of letters supporting in parentheses.)

1. TWRA should regulate tournaments using permit system, fees or other means (15)
2. Support trophy bass management and Florida bass stocking (11)
3. Support management based on biological data (not special interest groups) (10)
4. More bass stocking by TWRA (9)
5. Develop TWRA policy on aquatic vegetation (6)
6. (Angler recommendations for) changes to creel and length limits (6)
7. Stock Florida bass statewide (do not restrict to warmer areas) (5)
8. Make Bass Plan easier to read for general public (4)
9. Regulate recreational boating more (4)
10. Less harvest restriction (4)
11. Educate or make bass management data more available to public (3)
12. TWRA should prohibit eradication of aquatic vegetation (3)
13. TVA should regulate water levels to favor fisheries (3)
14. Establish closed fishing seasons (3)
15. TWRA should restrict summer fishing tournaments (3)
16. More enforcement of fishing regulations needed (3)
17. Bait restriction for tournaments should not be considered (2)
18. No tournament regulation (2)
19. TWRA should require species-specific license stamps to help fund management programs (2)
20. Maintain or plant milfoil (1)
21. Oppose trophy management (support high catch rates) (1)
22. Widen ramps and enhance access (1)
23. Exempt tournaments from observing size limits (1)
24. Favor reciprocal agreements where possible (1)
25. Allow more flexibility in setting PLRs in Bass Plan (1)
26. Eliminate statewide creel limit (manage each reservoir differently) (1)
27. Create statewide size limit (1)
28. Establish boating fees based on horsepower (1)
29. Establish and protect spawning areas in reservoirs (1)
30. More habitat enhancement work done by TWRA (1)
31. Produce TWRA tournament procedures manual (1)

* 89 requests were made by the general public to review the Bass Plan. 16 reviews were solicited from professional anglers, university researchers, and bass fishing organizations. 27 reviews were received from the general public. 3 solicited reviews were also received. Suggestions from these reviews were incorporated into consideration for the final draft.